Occupational Safety Competency 1.9

Competency 1.9 **Occupational safety personnel shall demonstrate a working level knowledge of safety in construction operations.**

1. Supporting Knowledge and Skills

a. Discuss the role of project planning and analysis.

b. Discuss the effect of the transient and dynamic nature of construction activities on the safety program.

c. Discuss safety program considerations on multi-employer construction sites.

d. Discuss the requirements for, the purpose of, and the application of, appropriate preliminary and activity hazard analysis.

e. Demonstrate the ability to:
- Evaluate construction operations and identify construction-related hazards
- Identify, interpret, and apply appropriate construction safety requirements
- Identify and implement appropriate control measures

f. Discuss excavation and trenching hazard and control considerations, including:
- Factors affecting soil stability in a trench
- Application of the different types of shoring, sloping, and shielding systems
- Excavation and trenching inspection considerations

g. Address the following confined space hazard considerations for construction operations:
- Describe the characteristics of a confined space hazard
- Identify potential construction-related confined space locations
- Identify and discuss the application of confined space entry procedures

h. Discuss construction-related electrical considerations (i.e., temporary wiring; grounding; and exposed wires, equipment, or parts).

i. Discuss the following hazards and the use of appropriate controls associated with hoisting and rigging equipment and operations:
- Load test and inspection requirements for cranes
- Effects of boom angle and length on load limits
- Major signs of stress, strain, or other deterioration that must be evaluated when inspecting rigging equipment
- Hazards associated with electrical wires
- Appropriate lifting techniques and limitations, including the relationship between the crane operator and the guide

j. Discuss the following hazard control considerations associated with demolition operations:
   - Structural support considerations
   - Need for project planning and activity hazard analyses
   - Hazards associated with, and the appropriate techniques for removal of debris
   - Hazards associated with remaining energy sources, equipment, and materials (hazardous chemicals/wastes)

k. Identify sources of potential fall hazards and recommend appropriate controls.

l. Discuss construction related heat and cold stress hazards and identify appropriate control measures.

m. Identify general personal protective equipment (PPE) requirements for construction operations.

n. Discuss the hazards and identify appropriate controls associated with construction equipment and operations including, but not limited to:
   - Scaffolding and other elevated work structures or platforms
   - Powder-actuated tools
   - Heavy equipment (i.e., earth moving equipment) and traffic
   - Placement and temporary support of walls, floors, and other structures.

2. Self-Study Activities (corresponding to the intent of the above competency)

Below are two web sites containing many of the references you may need.

Web Sites		
Organization	**Site Location**	**Notes**
Department of Energy	http://wastenot.inel.gov/cted/stdguido.html	DOE Standards, Guides, and Orders
OSHA	http://www.osha-slc.gov/	OSHA documents and search engine
U.S. House of Representatives	http://law.house.gov/cfr.htm	Searchable Code of Federal Regulations

Read the Summary section below.

Occupational Safety Competency 1.9

Read DOE Order 5480.9A, *Construction Project Safety and Health Management.*

EXERCISE 1.9-A Discuss the role of project planning and analysis.

EXERCISE 1.9-B Discuss the effect of the transient and dynamic nature of construction activities on the safety program.

EXERCISE 1.9-C Discuss safety program considerations on multi-employer construction sites.

EXERCISE 1.9-D Complete a matrix similar to that shown below, discussing the requirements for, the purpose of, and the application of, appropriate preliminary and activity hazard analysis.

Hazard Analyses Information		
	Preliminary Hazard Analysis	**Activity Hazard Analysis**
Requirement Source		
Purpose		
Application		

Review OSHA 2209, *OSHA Handbook for Small Businesses*.

Review "Safety and Health Regulations for Construction, Subpart K, Electrical," 29 CFR 1926, *Surveillance Guide*, prepared for DOE-ORO.

EXERCISE 1.9-E Work with a subject matter expert at your site to complete the following activities.

- Select an area of a facility or select a construction activity to be assessed. Using a checklist, evaluate construction operations and identify construction-related hazards. One possible source is the Self-Inspection Checklists in OSHA 2209, *OSHA Handbook for Small Businesses*.
- Identify, interpret, and apply appropriate construction safety requirements. One useful reference for this activity is the "Safety and Health Regulations for Construction, Subpart K, Electrical," 29 CFR 1926, *Surveillance Guide*, prepared by DOE-ORO.
- Identify and implement appropriate control measures.

Review 29 CFR 1926, Subpart P, “Excavations.”

EXERCISE 1.9-F Discuss excavation and trenching hazard and control considerations including:

- Factors affecting soil stability in a trench
- Application of the different types of shoring, sloping, and shielding systems
- Excavation and trenching inspection considerations

Review DOE-EM-STD-5503-94, *Guidelines For Development of Site-Specific Health and Safety Plans*, published by EM-40.

EXERCISE 1.9-G Address the following confined space hazard considerations for construction operations:

- Describe the characteristics of a confined space hazard
- Identify potential construction related confined space locations
- Identify and discuss the application of confined space entry procedures

Review 29 CFR 1926.403-405.

EXERCISE 1.9-H Using 29 CFR 1926, discuss construction-related electrical considerations, including temporary wiring; grounding; and exposed wires, equipment, or parts.

Review DOE/ID-10500, *Department of Energy Hoisting and Rigging Manual*.

EXERCISE 1.9-I Address the following items associated with hoisting and rigging equipment and operations:

- Load test and inspection requirements for cranes
- Effects of boom angle and length on load limits
- Major signs of stress, strain, or other deterioration that must be evaluated when inspecting rigging equipment
- Hazards associated with electrical wires
- Appropriate lifting techniques and limitations, including the relationship between the crane operator and the guide

Review 29 CFR Part 1926, Subpart T.

EXERCISE 1.9-J Discuss the following hazard control considerations associated with demolition operations:

- Structural support considerations
- Need for project planning and activity hazard analyses
- Hazards associated with and the appropriate techniques for removal of debris
- Hazards associated with remaining energy sources, equipment, and materials (hazardous chemicals/wastes)

Review 29 CFR Part 1926, Subparts C, E, H, L, and M.

EXERCISE 1.9-K Identify potential fall hazards and recommend preventive measures.

Review Chapter 1 of *Fundamentals of Industrial Hygiene*; B.A. Plog, G.S. Benjamin, and M.A. Kerwin; National Safety Council; or another industrial hygiene-related text regarding heat and cold stress.

EXERCISE 1.9-L Construct a matrix similar to the one shown below that describes heat and cold stress hazards and identifies appropriate control measures.

Heat and Cold Stress-Related Hazards		
Type	**Factors**	**Control Measures**
Heat		
Cold		

Review 29 CFR Part 1926, Subpart E.

EXERCISE 1.9-M Using 29 CFR 1926, state the general personal protective equipment (PPE) requirements for construction operations.

EXERCISE 1.9-N Construct a matrix similar to the one shown below that describes the listed hazards and identifies appropriate control measures.

Construction Equipment- and Operations-Related Hazards		
Type	**Description**	**Control Measures**
Scaffolding		
Powder-Actuated Tools		
Heavy Equipment		

3. Summary

Project Planning

As with any project, construction activities are safer and more efficient when an appropriate amount of planning is done. This is particularly important to personnel safety. Construction contractors are required by DOE in order to evaluate the work associated with each project phase and to identify specific hazards to which worksite employees and other worksite personnel may potentially be exposed. This analysis also provides the data needed to identify appropriate control measures.

Dynamic Nature of Construction

Construction activities are safer and more efficient when an appropriate amount of planning is done. The transient and dynamic nature of construction activities makes the need for that planning of paramount importance. It is very easy under construction conditions to make on-the-spot decisions that may advance the construction cause while negating the advantages of safety planning. Therefore, safety issues must be considered any time activities stray from the planned path.

Safety Program Considerations on Multi-Employer Construction Sites

Multi-employer construction sites offer unique problems for safety programs. Each subcontractor firm is responsible for some form of a safety program, as is the primary contracting organization. This situation creates natural problem areas at the responsibility interfaces. The solution to this problem is to identify one person who has total responsibility for the overall safety program. Another issue that occasionally occurs on multi-employer sites is that existing safety programs within the subcontractor organizations may not be compatible with each other or with the primary contractor's program. These concerns should be resolved in the contract establishment process.

Hazard Analyses

Hazard Analyses Information		
	Preliminary Hazard Analysis	**Activity Hazard Analysis**
Requirements	DOE Order 5480.9A	DOE Order 5480.9A
Purpose	To reduce the likelihood of exposure of worksite employees and other worksite personnel by reviewing the planned work prior to start of the project	To reduce the likelihood of exposure of worksite employees and other worksite personnel during individual phases of construction by reviewing the planned work prior to the start of each phase
Application	• Identify the anticipated construction phases • Identify the types of hazards associated with each anticipated phase of the project • Identify potential control measures and programs necessary to protect employees and others at the worksite • Identify the phases for which requirements for protective measures must exist	• Identify the specific hazards associated with each activity to be performed in that phase of construction • Identify the actual corrective measures planned to control the hazards • Develop drawings and/or other documentation for all protective measures • Designate and identify the qualifications of the person that will conduct inspections where required

Assessing Safety Programs

An assessment or inspection of construction activities can be a useful tool. A subject matter expert at your site should be consulted for review of this area. One reference that provides assistance for the first item is the "Self-Inspection Checklists" in OSHA 2209, *OSHA Handbook for Small Businesses*. A reference that provides assistance for the second and third activities as well as an actual assessment plan is the "Safety and Health Regulations for Construction, Subpart K, Electrical," 29 CFR 1926*, Surveillance Guide*, prepared by DOE-ORO.

Excavation and Trenching Hazards

There are a number of factors that affect soil stability in a trench. Some of the more common factors include the following:

- Nearby traffic
- Nearness of structures
- Condition of nearby structures
- Soil type
- Surface and ground water
- The water table
- Overhead and underground utilities
- Weather

OSHA requires that, in all excavations, employees exposed to potential cave-ins must be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area. Details regarding sloping and shoring can be found in 29 CFR 1926, Subpart P, "Excavations."

29 CFR 1926, Subpart P requires that a competent person inspect, on a daily basis, excavations and the adjacent areas for possible cave-ins, failures of protective systems and equipment, hazardous atmospheres, or other hazardous conditions. If these conditions are encountered, exposed employees must be removed from the hazardous area until the necessary safety precautions have been taken. Inspections are also required after natural (e.g., heavy rains) or man-made events such as blasting that may increase the potential for hazards.

Confined Space Hazards

A permit-required confined space has one or more of the following characteristics:
- Contains or has a potential to contain a hazardous atmosphere
- Contains a material that has the potential for engulfing an entrant
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section
- Contains any other recognized serious safety or health hazard

There are numerous potential construction-related confined space locations. These include, but are not limited to, the following:
- Manholes
- Stacks
- Storage tanks
- Trailers
- Tank cars
- Vats
- Vessels
- Pits
- Sumps
- Hoppers
- Bins
- Trenches
- Rooms
- Tunnels
- Pipes

The following are steps for entry into a confined space. They are generic and, therefore, apply to many confined space entries. However, they may be altered by site or facility procedures.
- Complete the initial portions of a confined space entry permit
- Confirm or perform training to establish personnel proficiency in the duties required
- Test the atmosphere
- Set up atmospheric monitoring to be performed throughout the entry
- If a hazardous atmosphere is detected, evaluate to determine the cause
- Take measures to protect employees before entry is made
- Require proper respiratory equipment if needed
- Complete the confined space entry permit
- Allow entry only after all requirements of the permit are met and it is reviewed and signed by the entry supervisor or job leader

Construction-Related Electrical Hazards

29 CFR 1926 covers each of the following areas in detail.

- Temporary wiring -- 29 CFR 1926.405 addresses temporary wiring. General requirements exist related to the following:
  - Origination of feeders and branch circuits
  - Location of branch-circuit conductors
  - Types of receptacles
  - Disconnect switches
  - Lamp guards
  - Temporary light suspension
  - Portable electric lighting
  - Cable and raceway systems
  - Protection of flexible cords and cable
  - Extension cords
- Grounding -- 29 CFR 1926.404 covers grounding and includes the following general requirements:
  - Use of ground fault circuit interrupters or an assured equipment grounding conductor program
  - Identification of conductors
  - Polarity of connections
  - Use of grounding terminals and devices
- Exposed wires, equipment, or parts -- 29 CFR 1926.403 covers guarding. General requirements state that guarding shall be provided to prevent access of other than authorized and qualified personnel.

Hoisting and Rigging

The following is a simple list of basic load test and inspection requirements for cranes.

- Prior to initial use, all new, extensively repaired, or altered cranes shall be tested by or under the direction of a qualified inspector. A functional test of the crane under a normal operating load should be made prior to putting the crane back in service.
- Equipment shall be inspected by a competent person before each use and during use, and all deficiencies shall be corrected before further use.
- An annual inspection of the hoisting machinery shall be made by a competent person or by a government or private agency recognized by the U.S. Department of Labor. Records shall be kept of the dates and results of each inspection.

There are several effects that boom angle and length have on load limits.

- A safe load depends upon boom length, boom angle, and working radius.
- Always operate within the rated capacity of the machine.
- Always use the shortest boom possible.
- Never operate the boom at a higher angle than shown on the capacity charts.

Major signs of stress, strain, or other deterioration must be evaluated when inspecting rigging equipment. The following is a partial list of items to be inspected.

- Equipment shall operate with a smooth, regular motion without any hesitation, abnormal vibration, binding, gross shimmy, or irregularity.
- There shall be no apparent damage, excessive wear, or deformation of any part of the equipment.
- All safety devices, load indicators, boom angle and radius indicators, controls, and other operating parts of the equipment shall be checked during each inspection and shall be in good working order.
- Any defects shall be corrected or repaired before the equipment is put into service.
- Parts found to be defective as a result of any inspection or nondestructive examination shall be replaced or repaired as directed by the cognizant line manager or a designated alternate.

Information on the various types of inspections that must be performed on cranes and rigging equipment can be found in DOE/ID-10500, *Department of Energy Hoisting and Rigging Manual*.

There are also possible hazards associated with the use of cranes near electrical wires. Extreme caution must be used when traveling or working a crane near electrical wires. Special procedures are required except where the electrical distribution and transmission lines have been deenergized and are visibly grounded at the point of work.

- If cage-type boom guards, insulating links, or proximity-warning devices are used, they cannot replace having the electrical distribution and transmission lines deenergized and visibly grounded at the point of work.
- Communicate with the owners of the lines prior to commencement of the work and request their cooperation.
- Consider all overhead conductors to be energized unless and until the person owning the conductor or the electric utility verifies that it is not energized.
- Observe the minimum clearance requirements that are based on voltage.
- Observe the signs at the operator's station and on the outside of the crane warning of possible electrocution.

Appropriate lifting techniques and limitations are important in the operation of a crane. Lifting techniques and limitations can be found in DOE/ID-10500, *Department of Energy Hoisting and Rigging Manual*.

The relationship between the crane operator and the guide is also very important for safe operation.

- All personnel acting as signalers during crane operations shall be clearly identified to the crane operator by the use of one or more of the following: orange hardhat, gloves, and/or vest.
- In those cases where the crane operator cannot see the signaler, a second person (relay signaler) shall be stationed where he/she can see both the signaler and the crane operator and relay signals to the operator.
- Where voice (direct or two-way radio) communication is used, the signaler shall communicate directly with the operator, not through a third person.
- The operator shall recognize signals only from the designated signaler, except that a STOP signal shall be obeyed no matter who gives it.
- The standard signals for DOE use of the particular type of crane or hoist being used shall be as specified in the latest edition of the American National Standards Institute (ANSI) B30 chapters.

Demolition Hazards

There are a number of considerations associated with demolition operations. Some of those are detailed below.

- Structural support considerations
  - Prior to starting all demolition operations, OSHA Standard 1926.850(a) requires that an engineering survey of the structure must be conducted by a competent person. The purpose of this survey is to determine the condition of the framing, floors, and walls so that measures can be taken, if necessary, to prevent the premature collapse of any portion of the structure. When indicated as advisable, any adjacent structure(s) or improvements should also be similarly checked.
  - If the structure to be demolished has been damaged by fire, flood, explosion, or some other cause, appropriate measures, including bracing and shoring of walls and floors, shall be taken to protect workers and any adjacent structures.
- Need for project planning and activity hazard analyses
  - Before the start of every demolition job, the demolition contractor should take a number of steps to safeguard the health and safety of workers at the job site. These preparatory operations involve the overall planning of the demolition job, including the methods to be used to bring the structure down, the equipment necessary to do the job, and the measures to be taken to perform the work safely. Planning for a demolition job is as important as actually doing the work.

- Hazards associated with and the appropriate techniques for removal of debris
  - Various hazards are associated with the removal of debris. Several OSHA requirements that relate to the removal of debris. General precautions include the following:
    - When debris is dropped through holes in the floor without the use of chutes, the area onto which the material is dropped shall be completely enclosed with barricades.
    - Signs to warn of the hazard of falling materials shall be posted at each level. Sign removal shall not be permitted in the lower area until debris handling ceases above.
    - Any chute opening into which workmen dump debris shall be protected by a substantial guardrail.
    - Walls that are to serve as retaining walls against which debris will be piled shall not be so used unless capable of safely supporting the imposed load.
    - Before demolishing any floor arch, debris and other material shall be removed from such arch and other adjacent floor area.
    - Demolition of floor arches shall not be started until the arches have been cleared of debris and any other unnecessary materials.
    - The storage of waste material and debris on any floor shall not exceed the allowable floor loads.
- Hazards associated with remaining energy sources, equipment, and materials (hazardous chemicals/wastes)
  - One of the most important elements of the prejob planning is the location of all utility services. All electric, gas, water, steam, sewer, and other service lines should be shut off, purged (if necessary), capped, or otherwise controlled, at or outside the building before demolition work is started. In each case, any utility company that is involved should be notified in advance, and its approval or services, if necessary, shall be obtained.
  - If it is necessary to maintain power, water, or other utilities during demolition, such lines shall be temporarily relocated as necessary and/or protected. The location of all overhead power sources should also be determined, as they can prove especially hazardous during any machine demolition. All workers should be informed of the location of any existing or relocated utility service.
  - It shall also be determined if any type of hazardous chemicals, gases, explosives, flammable material, or similar dangerous substances have been used or stored on the site. If the nature of a substance cannot be easily determined, samples should be taken and analyzed by a qualified person prior to demolition. The hazardous materials may have to be removed prior to the start of demolition.

Potential Fall Hazards

There are a large number of possible fall hazards. The following table illustrates some examples.

Potential Fall Hazards and Preventive Measures	
Hazard	**Preventive Measure**
Tripping	• Housekeeping • Proper illumination • Guardrails and handrails
Slipping	• Housekeeping • Safety shoes with nonskid soles • Level walking surfaces
Working at Elevations	• Safety lines, harnesses, and lanyards • Ladders and scaffolds inspections • Safety nets
Faulty Ladders, Scaffolds, or Guardrails	• Ladders, scaffolds, and guardrails inspections • Written safety policy to never step on top platform of ladder • Safety cage or rail

Heat Stress or Cold Stress

The construction environment, by its very nature, requires workers to endure extremes of weather and other environmental conditions. Two of these are heat and cold stress. The following table describes each and provides several possible control measures.

Hazards Related to Heat Stress or Cold Stress		
Type	**Factors**	**Control Measures**
Heat	• Common problem • Evaluation of heat stress is not simple • People function efficiently only in a very narrow body temperature range • Protective clothing • Can cause: - Heat stroke - Heat exhaustion - Heat cramps	• Acclimatization periods • Work and rest regimens • Distribution of work load with time • Regular breaks • Provision for water intake • Application of engineering controls
Cold	• Also a common problem • Physical activity increases loss of body heat in a cold environment • Can cause: - Hypothermia - Frostbite	• Work and rest regimens • Distribution of work load with time • Regular breaks • Provision for water intake • Protective clothing • Application of engineering controls

General OSHA Personal Protective Equipment (PPE) Requirements for Construction Operations

- Application -- Protective equipment, including personal protective equipment (PPE) shall be provided, used, and maintained in a sanitary and reliable condition whenever necessary to prevent injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact.
- Employee-owned equipment -- Where employees provide their own protective equipment, the employer shall be responsible to ensure its adequacy, including proper maintenance and sanitation of such equipment.
- Design -- All PPE shall be of safe design and construction in order for the work to be performed.

Construction Equipment- and Operations-Related Hazards

There are a large number of possible items that could be covered under this topic. The following are some examples.

Construction Equipment- and Operations-Related Hazards		
Type	**Hazard Description**	**Control Measures**
Scaffolding	• Falls from scaffolding • Collapse of scaffolding	• Sound footing • Capable of carrying at least four times the maximum intended load • Guardrails and toeboards installed • Planking is scaffold grade or equivalent
Powder-Actuated Tools	• Accidental firing causing injury • Powder burns • Misfire • Flying dirt, scale, etc. • Ignition of explosive or combustible atmosphere	• Only trained employees shall be allowed to operate powder-actuated tools • All powder-actuated tools shall be tested daily before use and all defects discovered before or during use shall be corrected • Tools shall not be loaded until immediately before use. Loaded tools shall not be left unattended • Eye/face protection • Hearing protection
Heavy Equipment	• Hearing damage • Injury from being struck by vehicle • Injury from flying objects • Operating accidents • Combustion by-products	• Wear hearing protection • Maintain awareness of equipment • Avoid heavy traffic areas • Post warning signs • Wear hard hats • Ensure adequate ventilation • Ensure adequate guarding • Frequent equipment inspections • Proper equipment maintenance • Audible reverse warning

4. Exercise Solutions

EXERCISE 1.9-A Discuss the role of project planning and analysis.

ANSWER 1.9-A As with any project, construction activities are safer and more efficient when an appropriate amount of planning is done. This is particularly important to personnel safety. Construction contractors are required by DOE to evaluate the work associated with each project phase and to identify specific hazards to which worksite employees and other worksite personnel may potentially be exposed. This analysis also provides the data needed to identify appropriate control measures.

EXERCISE 1.9-B Discuss the effect of the transient and dynamic nature of construction activities on the safety program.

ANSWER 1.9-B Construction activities are safer and more efficient when an appropriate amount of planning is done. The transient and dynamic nature of construction activities makes the need for that planning of paramount importance. It is very easy under construction conditions to make on-the-spot decisions that may advance the construction cause while negating the advantages of safety planning. Therefore, safety issues must be considered any time activities stray from the planned path.

EXERCISE 1.9-C Discuss safety program considerations on multi-employer construction sites.

ANSWER 1.9-C Multi-Employer construction sites offer unique problems for safety programs. Each subcontractor firm is responsible for some form of a safety program, as is the primary contracting organization. This situation creates natural problem areas at the responsibility interfaces. The solution to this problem is to identify one person who has total responsibility for the overall safety program. Another issue that occasionally occurs on multi-employer sites is that existing safety programs within the subcontractor organizations may not be compatible with each other or with the primary contractor's program. These concerns should be resolved in the contract establishment process.

EXERCISE 1.9-D Complete a matrix similar to that shown in Exercise 1.9-D in Section 2, Self-Study Activities, discussing the requirements for, the purpose of, and the application of appropriate preliminary and activity hazard analysis.

ANSWER 1.9-D

Hazard Analyses Information		
	Preliminary Hazard Analysis	**Activity Hazard Analysis**
Requirements	DOE Order 5480.9A	DOE Order 5480.9A
Purpose	To reduce the likelihood of exposure of worksite employees and other worksite personnel by reviewing the planned work prior to start of the project	To reduce the likelihood of exposure of worksite employees and other worksite personnel during individual phases of construction by reviewing the planned work prior to the start of each phase
Application	• Identify the anticipated construction phases • Identify the types of hazards associated with each anticipated phase of the project • Identify potential control measures and programs necessary to protect employees and others at the worksite • Identify the phases for which requirements for protective measures must exist	• Identify the specific hazards associated with each activity to be performed in that phase of construction • Identify the actual corrective measures planned to control the hazards • Develop drawings and/or other documentation for all protective measures • Designate and identify the qualifications of the person that will conduct inspections where required

EXERCISE 1.9-E Work with a subject matter expert at your site to complete the following activities.

- Select an area of a facility or select a construction activity to be assessed. Using a checklist, evaluate construction operations and identify construction-related hazards. One possible source is the Self-Inspection Checklists in OSHA 2209, *OSHA Handbook for Small Businesses*.
- Identify, interpret, and apply appropriate construction safety requirements. One useful reference for this activity is the "Safety and Health Regulations for Construction, Subpart K, Electrical," 29 CFR 1926, *Surveillance Guide*, prepared for DOE-ORO.
- Identify and implement appropriate control measures

ANSWER 1.9-E An assessment or inspection of construction activities can be a useful tool. It is beyond the scope of this self study guide to cover this item in detail. A subject matter expert at your site should be consulted for review of this item. One reference that provides assistance for the first item is the Self-Inspection Checklists in OSHA 2209, *OSHA Handbook for Small Businesses*. A reference that provides assistance for the second and third activities as well as an actual assessment plan is the "Safety and Health Regulations for Construction, Subpart K, Electrical," 29 CFR 1926, *Surveillance Guide*, prepared by DOE-ORO.

EXERCISE 1.9-F Discuss excavation and trenching hazard and control considerations including:

- Factors affecting soil stability in a trench
- Application of the different types of shoring, sloping, and shielding systems
- Excavation and trenching inspection considerations

ANSWER 1.9-F

- There are a number of factors that affect soil stability in a trench. Some of the more common factors include the following:
  - Nearby traffic
  - Nearness of structures
  - Condition of nearby structures
  - Soil type
  - Surface and ground water
  - The water table
  - Overhead and underground utilities
  - Weather

- OSHA requires that, in all excavations, employees exposed to potential cave-ins must be protected by sloping or benching the sides of the excavation, supporting the sides of the excavation, or placing a shield between the side of the excavation and the work area. Details regarding sloping and shoring can be found in 29 CFR 1926, Subpart P, "Excavation."
- 29 CFR 1926, Subpart P requires that a competent person inspect, on a daily basis, excavations and the adjacent areas for possible cave-ins, failures of protective systems and equipment, hazardous atmospheres, or other hazardous conditions. If these conditions are encountered, exposed employees must be removed from the hazardous area until the necessary safety precautions have been taken. Inspections are also required after natural (e.g., heavy rains) or man-made events, such as blasting, that may increase the potential for hazards.

EXERCISE 1.9-G Address the following confined space hazard considerations for construction operations:

- Describe the characteristics of a confined space hazard
- Identify potential construction-related confined space locations
- Identify and discuss the application of confined space entry procedures

ANSWER 1.9-G

- A permit-required confined space has one or more of the following characteristics:
  - Contains or has a potential to contain a hazardous atmosphere
  - Contains a material that has the potential for engulfing an entrant
  - Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross-section
  - Contains any other recognized serious safety or health hazard
- There are numerous possible answers to this question. These include, but are not limited to, the following:
  - Manholes
  - Stacks
  - Storage tanks
  - Trailers
  - Tank cars

  - Vats
  - Vessels
  - Pits
  - Sumps
  - Hoppers
  - Bins
  - Trenches
  - Rooms
  - Tunnels
  - Pipes
- The following steps for entry into a confined space are generic and, therefore, apply to many confined space entries. However, these steps may be altered by site or facility procedures.
  - Complete the initial portion of a confined space entry permit
  - Confirm or perform training to establish personnel proficiency in the duties required
  - Test the atmosphere (O_2, explosive limits, toxic atmosphere) as required
  - Set up atmospheric monitoring to be performed throughout the entry
  - If a hazardous atmosphere is detected, evaluate to determine the cause
  - Take measures to protect employees before entry is made
  - Require proper respiratory equipment if needed
  - Complete the confined space entry permit
  - Allow entry only after all requirements of the permit are met and it is reviewed and signed by the entry supervisor or job leader.

EXERCISE 1.9-H Using 29 CFR 1926, discuss construction-related electrical considerations, including temporary wiring; grounding; and exposed wires, equipment, or parts.

ANSWER 1.9-H 29 CFR 1926 covers each of the following areas in detail.

- Temporary wiring -- 29 CFR 1926.405 covers temporary wiring. General requirements exist related to the following:
  - Origination of feeders and branch circuits
  - Location of branch-circuit conductors
  - Types of receptacles
  - Disconnect switches
  - Lamp guards
  - Temporary light suspension

  - Portable electric lighting
  - Cable and raceway systems
  - Protection of flexible cords and cable
  - Extension cords
- Grounding -- 29 CFR 1926.404 covers grounding and includes the following general requirements:
  - Use of ground fault circuit interrupters or an assured equipment grounding conductor program
  - Identification of conductors
  - Polarity of connections
  - Use of grounding terminals and devices
- Exposed wires, equipment, or parts -- 29 CFR 1926.403 covers guarding. General requirements exist that state that guarding shall be provided to prevent access of other than authorized and qualified personnel.

EXERCISE 1.9-I Address the following items associated with hoisting and rigging equipment and operations:

- Load test and inspection requirements for cranes
- Effects of boom angle and length on load limits
- Major signs of stress, strain, or other deterioration that must be evaluated when inspecting rigging equipment
- Hazards associated with electrical wires
- Appropriate lifting techniques and limitations including the relationship between the crane operator and the guide

ANSWER 1.9-I

- Load test and inspection requirements for cranes
  - Prior to initial use, all new, extensively repaired, or altered cranes shall be tested by or under the direction of a qualified inspector. A functional test of the crane under a normal operating load should be made prior to putting the crane back in service.
  - Equipment shall be inspected by a competent person before each use and during use, and all deficiencies shall be corrected before further use.
  - An annual inspection of the hoisting machinery shall be made by a competent person or by a government or private agency recognized by the U.S. Department of Labor. Records shall be kept of the dates and results of each inspection.

- Effects of boom angle and length on load limits
  - A safe load depends upon boom length, boom angle, and working radius.
  - Always operate within the rated capacity of the machine.
  - Always use the shortest boom possible.
  - Never operate the boom at a higher angle than shown on the capacity charts.
- Major signs of stress, strain, or other deterioration that must be evaluated when inspecting rigging equipment
  - Equipment shall operate with a smooth, regular motion without any hesitation, abnormal vibration, binding, gross shimmy, or irregularity.
  - There shall be no apparent damage, excessive wear, or deformation of any part of the equipment.
  - All safety devices, load indicators, boom angle and radius indicators, controls, and other operating parts of the equipment shall be checked during each inspection and shall be in good working order.
  - Any defects shall be corrected or repaired before the equipment is put into service.
  - Parts found to be defective as a result of any inspection or nondestructive examination shall be replaced or repaired as directed by the cognizant line manager or a designated alternate.

  Information on the various types of inspections that must be performed on cranes and rigging equipment can be found in DOE/ID-10500, *Department of Energy Hoisting and Rigging Manual*.

- Hazards associated with electrical wires
  - Extreme caution must be used when traveling or working a crane near electrical wires. Special procedures are required except where the electrical distribution and transmission lines have been deenergized and are visibly grounded at the point of work.
    - If cage-type boom guards, insulating links, or proximity-warning devices are used, they cannot replace having the electrical distribution and transmission lines deenergized and visibly grounded at the point of work.
    - Communicate with the owners of the lines prior to commencement of the work and request their cooperation.

        - Consider all overhead conductors to be energized unless and until the person owning the conductor or the electric utility verifies that it is not energized.
        - Observe the minimum clearance requirements that are based on voltage.
        - Observe the signs at the operator's station and on the outside of the crane warning of possible electrocution.

- Appropriate lifting techniques and limitations including the relationship between the crane operator and the guide
  - The relationship between the crane operator and the guide is very important for safe operation.
    - All personnel acting as signalers during crane operations shall be clearly identified to the crane operator by the use of one or more of orange hardhat, gloves, and/or vest.
    - In those cases where the crane operator cannot see the signaler, a second person (relay signaler) shall be stationed where he/she can see both the signaler and the crane operator and relay signals to the operator.
    - Where voice (direct or two-way radio) communication is used, the signaler shall communicate directly with the operator not through a third person.
    - The operator shall recognize signals only from the designated signaler, except that a STOP signal shall be obeyed no matter who gives it.
    - The standard signals for DOE use shall be as specified in the latest edition of the American National Standards Institute (ANSI) B30 chapters, for the particular type of crane or hoist being used.

  Lifting techniques and limitations can be found in DOE/ID-10500, *Department of Energy Hoisting and Rigging Manual*.

EXERCISE 1.9-J Discuss the following hazard control considerations associated with demolition operations:

- Structural support considerations
- Need for project planning and activity hazard analyses
- Hazards associated with and the appropriate techniques for removal of debris
- Hazards associated with remaining energy sources, equipment, and materials (hazardous chemicals/wastes)

ANSWER 1.9-J

- Structural support considerations
  - Prior to starting all demolition operations, OSHA Standard 1926.850(a) requires that an engineering survey of the structure must be conducted by a competent person. The purpose of this survey is to determine the condition of the framing, floors, and walls so that measures can be taken, if necessary, to prevent the premature collapse of any portion of the structure. When indicated as advisable, any adjacent structure(s) or improvements should also be similarly checked.
  - If the structure to be demolished has been damaged by fire, flood, explosion, or some other cause, appropriate measures, including bracing and shoring of walls and floors, shall be taken to protect workers and any adjacent structures.
- Need for project planning and activity hazard analyses
  - Before the start of every demolition job, the demolition contractor should take a number of steps to safeguard the health and safety of workers at the job site. These preparatory operations involve the overall planning of the demolition job, including the methods to be used to bring the structure down, the equipment necessary to do the job, and the measures to be taken to perform the work safely. Planning for a demolition job is as important as actually doing the work.
- Hazards associated with and the appropriate techniques for removal of debris
  - Various hazards are associated with the removal of debris. Several OSHA requirements exist that relate to the removal of debris. General precautions include the following:
    - When debris is dropped through holes in the floor without the use of chutes, the area onto which the material is dropped shall be completely enclosed with barricades.

        - Signs warning of the hazard of falling materials shall be posted at each level. Removal shall not be permitted in this lower area until debris handling ceases above.
        - Any chute opening, into which workmen dump debris, shall be protected by a substantial guardrail.
        - Walls, which are to serve as retaining walls against which debris will be piled, shall not be so used unless capable of safely supporting the imposed load.
        - Before demolishing any floor arch, debris and other material shall be removed from such arch and other adjacent floor area.
        - Demolition of floor arches shall not be started until they have been cleared of debris and any other unnecessary materials.
        - The storage of waste material and debris on any floor shall not exceed the allowable floor loads.
- Hazards associated with remaining energy sources, equipment, and materials (hazardous chemicals/wastes)
    - One of the most important elements of the prejob planning is the location of all utility services. All electric, gas, water, steam, sewer, and other service lines should be shut off, capped, or otherwise controlled at or outside the building before demolition work is started. In each case, any utility company that is involved shall be notified in advance, and its approval or services, if necessary, should be obtained.
    - If it is necessary to maintain any power, water, or other utilities during demolition, such lines shall be temporarily relocated as necessary and/or protected. The location of all overhead power sources should also be determined, as they can prove especially hazardous during any machine demolition. All workers should be informed of the location of any existing or relocated utility service.
    - It shall also be determined if any type of hazardous chemicals, gases, explosives, flammable material, or similar dangerous substances have been used or stored on the site. If the nature of a substance cannot be easily determined, samples should be taken and analyzed by a qualified person prior to demolition.

EXERCISE 1.9-K Identify potential fall hazards and recommend preventive measures.

ANSWER 1.9-K There are a large number of possible correct answers to this exercise. The following table shows some, but not all, of those possible answers.

Potential Fall Hazards and Preventive Measures	
Hazard	**Preventive Measure**
Tripping	• Housekeeping • Proper illumination • Guardrails and handrails
Slipping	• Housekeeping • Safety shoes with nonskid soles • Level walking surfaces
Working At Elevations	• Safety lines, harnesses, and lanyards • Ladders and scaffolds inspections • Safety nets
Faulty Ladders, Scaffolds, or Guardrails	• Ladders, scaffolds, and guardrails inspection • Written safety policy to never step on top platform of ladder • Safety cage or rail

EXERCISE 1.9-L Construct a matrix similar to the one shown in Exercise 1.9-L that describes heat and cold stress hazards and identifies appropriate control measures.

ANSWER 1.9-L The construction environment, by its very nature, requires workers to endure the extremes of weather and other environmental conditions. Two of these are heat and cold stress. The following table describes each and provides several possible control measures.

Heat- and Cold-Stress Related Hazards		
Type	**Factors**	**Control Measures**
Heat	• Common problem • Evaluation of heat stress is not simple • People function efficiently only in a very narrow body temperature range • Protective clothing • Can cause: - Heat stroke - Heat exhaustion - Heat cramps	• Acclimatization periods • Work and rest regimens • Distribution of work load with time • Regular breaks • Provision for water intake • Application of engineering controls
Cold	• Also a common problem • Physical activity increases loss of body heat in a cold environment • Can cause: - Hypothermia - Frostbite	• Work and rest regimens • Distribution of work load with time • Regular breaks • Provision for water intake • Protective clothing • Application of engineering controls

EXERCISE 1.9-M Using 29 CFR 1926, state the general personal protective equipment (PPE) requirements for construction operations.

ANSWER 1.9-M

- Application -- Protective equipment, including PPE shall be provided, used, and maintained in a sanitary and reliable condition whenever it is necessary in the function of any part of the body through absorption, inhalation, or physical contact.
- Employee-owned equipment -- Where employees provide their own protective equipment, the employer shall be responsible to assure its adequacy, including proper maintenance, and sanitation of such equipment.
- Design -- All PPE shall be of safe design and construction for the work to be performed.

EXERCISE 1.9-N Construct a matrix similar to the one shown in Exercise 1.9-N that describes the listed hazards and identifies appropriate control measures.

ANSWER 1.9-N There are a large number of possible correct answers to this exercise. The following table shows some, but not all, of those possible answers.

Construction Equipment- and Operations-Related Hazards		
Type	**Description**	**Control Measures**
Scaffolding	• Falls from scaffolding • Collapse of scaffolding	• Sound footing • Capable of carrying at least four times the maximum intended load • Guardrails and toeboards installed • Planking is scaffold grade or equivalent
Powder Actuated Tools	• Accidental firing causing injury • Powder burns • Misfire • Flying dirt, scale, etc. • Ignition of explosive or combustible atmosphere	• Only trained employees shall be allowed to operate powder-actuated tools • All powder-actuated tools shall be tested daily before use and all defects discovered before or during use shall be corrected • Tools shall not be loaded until immediately before use. Loaded tools shall not be left unattended • Eye/face protection • Hearing protection
Heavy Equipment	• Hearing damage • Injury from being struck by vehicle • Injury from flying objects • Operating accidents • Combustion by-products	• Wear hearing protection • Maintain awareness of equipment • Avoid heavy traffic areas • Post warning signs • Wear hard hats • Ensure adequate ventilation • Ensure adequate guarding • Frequent equipment inspections • Proper equipment maintenance